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RESEARCH PAPER

A Comparison of the Utility and Agronomic Traits of Indigenous and Exotic Trees in the Mount Kenya Region

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Abstract On-farm indigenous (*Cordia africana*) and exotic (*Grevillea robusta*) tree species were compared in terms of the quality of their utility and their agronomic traits in the Meru Central district of Kenya. These two species are the most common indigenous and exotic trees, respectively, among the recorded 117 trees on farms. Interviews with farmers and collected documents on tree felling and planting showed that farmers considered *C. africana* to be more useful than *G. robusta*. However, farmers wanted to plant more *G. robusta* than *C. africana* because the easily established and fast growing *G. robusta* has a higher short-term contribution to the household economy. The advantages of *C. africana*, however, should be redefined in terms of its long-term contribution to farmers; *C. africana* contributes to farming more effectively than does *G. robusta*. The lower growth performance and relative difficulty in the establishment of *C. africana* can be compensated for by its higher timber quality and coppicing ability.

Keywords *Cordia africana* · *Grevillea robusta* · On-farm trees · Long-term contribution · Coppicing

Introduction

Trees on farms have many important roles to play; they improve soil fertility, prevent soil erosion, increase land productivity, and provide fuelwood and timber for domestic use (ICRAF 1992; Nair 1993). Such trees have been increasingly important for producing commercial timber in recent years because timber from natural forests has become increasingly less available, due to logging bans, and the

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expansion of industrial forest plantations has been limited (Holding-Anyonge and Roshetko 2003). In addition, these trees can contribute to the economic improvement of rural livelihoods. Trees on farms may be sold or mortgaged to cope with contingencies such as social conventions, physical incapacity, natural disasters, and unproductive expenditures (Spiers and Stewart 1992; Chambers et al. 1993; Holding-Anyonge and Roshetko 2003; Okorio et al. 2004).

The most popular species of trees grown on farms in Kenya are exotic species, and include *Grevillea robsta*, *Eucalyptus* spp., and *Cupressus lusitanica* (Spiers and Stewart 1992; Mugendi and Nair 1997; Wekesa et al. 2005). These species are preferred as on-farm trees because they are drought tolerant and fast growing, and thus provide a rapid and reliable source of timber. However commercially oriented choice of on-farm trees may lead a reduction in original agroforestry benefits such as a source of food, soil fertility, erosion control, water management, and biodiversity. Only limited information exists for deciding whether exotic species are suitable substitutes for indigenous species from the point of view of the original benefits, and for determining in what respect exotic species are more useful than indigenous species.

The purpose of this study was to compare on-farm indigenous and exotic species in terms of their utility and their agronomic traits, in the Meru Central district of Kenya. Meru people have long used indigenous trees (Bernard 1972) and have used several exotic species for the last 50 years (Kamweti 1992; Spiers and Stewart 1992; Takaoka 2002). This paper focuses on *Cordia africana* and *Grevillea robusta* which are the most useful indigenous and exotic species, respectively, for Meru (Imenti) farmers (Takaoka 2002). The farmers have recently increased the rate of planting *G. robusta* instead of *C. africana* on their farms.

The Study Area

The study area is located in the Meru Central district on the north-eastern slopes of Mount Kenya. The district comprises of 10 administrative divisions, 50 locations, and 144 sub-locations (referred to here as villages). The six villages investigated—Katheri, Naari, Kiirua, Ruiri, Rwarera, and Mugae—are situated along an altitudinal transect on the slope of the mountain (Fig. 1). Rainfall declines considerably with the decrease in altitude from Katheri (>1200 mm per year; 1880 m) to Mugae (about 600 mm; 1280 m).

Maize, beans, and Irish potatoes are the major food crops in all villages. Tea and coffee are grown mainly in Katheri and Naari, whereas sorghum, millet, and cotton are planted in Rwarera and Mugae. Crop yields are highly sensitive to weather conditions in the lower slope areas, including Kiirua, Ruiri, Rwarera, and Mugae. Heavy rain during 1997–1998 and drought during 1999–2001 caused crop failure in the areas (Takaoka 2005). Such disasters caused economic hardship, which may have prompted some farmers to cut on-farm trees.

C. africana is scattered extensively throughout crop lands. It is usually found in and around maize and bean fields. *G. robusta* is the most common tree on farms throughout the Kenyan highlands (Ongugo 1992; Mugendi and Nair 1997). It is found growing mainly along farm boundaries.

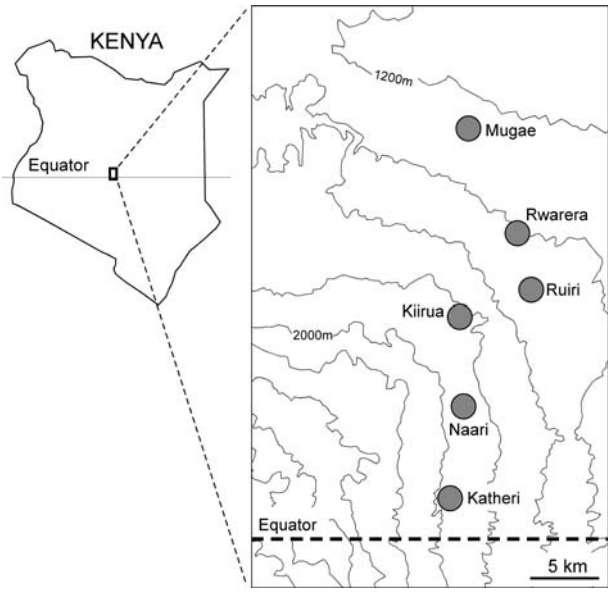

Fig. 1 Map showing the location of studied villages. Contour interval is 200 m

Research Method

Sixty-seven randomly selected farms were visited in the six villages in February 1999 and August 2000. The sampling frame comprised of all the farms within the villages that had on-farm trees. Natural and planted trees were described on each farm, and interviews were conducted to ask how farmers use the trees. Preliminary results were reported in Takaoka (2002). Interviews were also conducted in August 2004 at 19 farms in the three villages with different climate conditions (Katheri, Ruiri, and Rwarera), to determine farmers' preferences for the use of *C. africana* and *G. robusta* and their perceptions of the agronomic traits of these species.

Records of felling permission for March 2003 to July 2004 were obtained from the forestry office of Meru Central district in August 2004. Farmers are required to obtain permission from the office before they fell on-farm trees. The permission system changed in March 2003; permission documents prior to the new system have been lost or were not filed. Records of seedling distribution to farmers were also obtained from the office. The office supplies farmers with tree seedlings to promote the planting of trees on farms.

Survey Findings

Tree Use by Farmers

A total of 117 tree species were recorded, including 19 exotic species. The presence of indigenous trees appeared to depend on rainfall (Table 1). No single indigenous

Table 1 Distribution of major on-farm trees and their origin (planted or natural)

Village (number of farms)	Katheri (12)			Naari (10)			Kiirua (14)			Ruiri (11)			Rwarera (11)			Mugae (9)		
Origin	P	N	U	P	N	U	P	N	U	P	N	U	P	N	U	P	N	U
Vitex keniensis	9	3	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Olea europaea ssp. *africana*	4	1	–	3	8	–	1	5	2	5	4	2	–	–	–	–	–	–
Croton macrostachyus	–	2	1	1	1	2	–	–	–	–	–	3	–	–	–	–	–	–
Cordia africana	8	9	1	5	1	–	4	2	1	6	6	1	7	3	–	–	–	–
Euclea divinorum	–	–	1	–	2	1	–	7	2	–	–	3	–	2	–	–	–	–
Erythrina abyssinica	–	–	–	2	1	2	–	6	–	–	1	–	–	–	–	–	–	–
Dombeya rotundifolia	–	–	–	–	1	–	–	1	2	–	4	4	–	–	–	–	–	–
Azanza garckeana	–	–	–	–	1	–	–	1	–	2	2	6	–	1	1	–	–	–
Combretum molle	–	–	–	–	2	–	–	1	–	–	6	3	–	1	–	–	–	–
Grewia bicolor	–	–	–	–	1	–	–	–	1	–	3	3	–	1	1	–	–	–
Acacia nilotica	–	–	–	–	–	–	1	–	1	–	1	1	–	5	5	–	–	2
Acacia xanthophloea	–	–	–	–	–	–	–	2	–	–	–	–	–	4	6	–	1	2
Acacia tortilis	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1	–	4	4
Grevillea robusta	12	–	–	9	–	–	13	–	–	11	–	–	8	–	–	3	–	–
Eucalyptus spp.	4	–	–	2	–	–	3	–	–	1	–	–	2	–	–	1	–	–

Only trees found on 10 or more farms are reported. P: planted, N: naturally established, U: unknown

species occurred in all six villages. Some indigenous species including *Olea europaea* ssp. *africana* and *C. africana* had a wide range of distribution, occurring in most villages. Others were restricted to particular villages in the study area, probably owing to the difference in rainfall conditions. In contrast, the exotic species, *G. robusta* and *Eucalyptus* spp. (*E. saligna, E. maculata*, and *E. grandis*) were found in every village.

Some indigenous trees on the farms had been planted or had naturally established after the farms had been established. Others had been left standing when the farm was cleared, as was often the case in drier villages including Rwarera and Mugae.

Trees on farms were used for many purposes (Table 2). Indigenous trees contributed to farming by providing shade and manure for crops, and fodder and medicine for domestic animals. They also provided firewood, charcoal, and timber for domestic use and trade. In contrast, exotic trees contributed less to farming than indigenous trees. Many farmers reported a negative effect of *Eucalyptus* spp. on crops. Eucalypt trees compete with crops for water. Exotic trees were mainly used for firewood and timber.

Felling and Planting Trees

According to the records of felling permission in Meru Central district, farmers harvested on-farm trees for three main purposes. First, they felled trees to obtain construction materials and fuelwood, both of which were mainly for domestic use.

Table 2 Trees grown on farms and their uses

Origin	Scientific name	Farming					Food			Wood					
		Shade	Manure	Fodder	Bee foraging	Medicine (animal)	Fruit	Tea/ soup	Medicine (human)	Firewood	Charcoal	Timber	Posts/ poles	Furniture/ utensils	Fiber
Indigenous	*Vitex keniensis*		+	+						++	+	++		+	
	Croton macrostachyus	+	+			+			++	++		+			
	Olea europaea ssp. *africana*	+		+	+	+		+	++	++	+	+	+	+	
	Cordia africana	++	++	++	++		+		+	++	+	++		++	++
	Erythrina abyssinica	+	+	+	+	+			+	++		++		+	
	Euclea divinorum	+		+		+			+	++	++		+		
	Dombeya rotundifolia		+	++						++	++	+	+		
	Azanza garckeana	+	+	++			+			++	++	+	+	+	+
	Combretum molle	+	+	+						++	++		+		
	Grewia bicolor		+	++	+	+	+			++	++		+	+	++
	Acacia xanthophloea	+		+		+			+	++	++		+		
	Acacia nilotica	+		++				++	+	++	++	+	+		
	Acacia tortilis	+		++					+	++	++	+	+		
Exotic	*Grevillea robusta*	+	+	++						++	+	++	+		
	Eucalyptus spp.									++	+	++	+		

Source: Compiled from Takaoka (2002).

Trees found on 10 or more farms are reported; ++: major use, +: minor use

Second, they earned cash by selling timber and logs to pay school, hospital, and other fees. Of the total number of felled trees with permission, 52% were for cash income. Third, farmers felled trees to improve the farming environment by providing space for crop plants and reducing shading. The felling records included applications from five of the six villages visited, namely Katheri, Naari, Kiirua, Ruiri, and Rwarera. Of the 64 trees felled in the five villages, 57 were exotic, the most commonly felled exotic species being *G. robusta*.

Records of seedling distributions to farmers by the forestry office of Meru Central district were obtained for Katheri, Naari, and Kiirua. Exotic species dominated distributions to all these villages, and the major species distributed varied between villages. *G. robusta* was distributed in the highest numbers to Katheri and Kiirua, followed by Naari, ranging from 35 to 99% of the total for each village. *Cupressus lusitanica* was distributed in the highest numbers to Naari (60% of the total) and the third highest to Kiirua (11%). *Eucalyptus* spp. accounted for 14% in Kiirua. Indigenous trees including *C. africana* and *Vitex keniensis* accounted for less than 5% of the seedlings distributed to these three villages.

Comparison between *Grevillea robusta* and *Cordia africana*

The comparison of *G. robusta* and *C. africana* showed that *C. africana* was preferred as a provider of timber, fodder, manure, and shade (Table 3). *C. africana* provides hard, high-quality timber, although it does not usually grow straight. Firewood from *G. robusta* is preferred to that from *C. africana* because wood harvested from *G. robusta* dries faster than that from *C. africana*. Charcoal from *G. robusta* is also preferred to that from *C. africana*, although neither is frequently used for making charcoal. Katheri seems to differ in proportion of farmers' preferences for shade compared to Ruiri and Rwarera. Farmers do not necessarily need large leaf trees such as *C. africana* in Katheri where increased cloud cover reduces the solar radiation. *C. africana* stood higher in farmers' overall estimations of usefulness. However, this was inconsistent with the demand for seedlings for planting on farms; farmers wanted to plant more *G. robusta* than *C. africana*.

According to the farmers' perceptions of the agronomic traits of *G. robusta* and *C. africana*, it is easier to establish seedlings of *G. robusta* than those of *C. africana*. Sixteen of 19 interviewed farmers perceived the ease of establishing *G. robusta.* A farmer in Rwarera reported that every *G. robusta* seedling planted had established, whereas only 6 out of 30 *C. africana* seedlings had established. Farmers believed that *G. robusta* grew faster than *C. africana*. Seventeen farmers reported higher growth performance in *G. robusta* than *C. africana*. The ability of *C. africana* to produce stump sprouts (coppicing) was thought to be greater than that of *G. robusta* by all 19 farmers. *G. robusta* sprouts only if it is young, whereas *C. africana* sprouts regardless of age. In fact, sprouting was found on a *C. africana* stump in Katheri that was 97 cm in diameter at stump height. Farmers believed that the susceptibility of *G. robusta* to termite damage is higher than that of *C. africana.* This was one of the reasons why they preferred *C. africana* as timber (Table 3). There was a difference between the species with respect to the effect of tree roots on

Table 3 Farmers' preferences for *Grevillea robusta* (g) and *Cordia africana* (c)

Village	Katheri		Ruiri		Rwarera	
Species	g	c	g	c	g	c
Which provides better timber?	1	4	1	7	0	6
Which provides better firewood?	4	1	7	1	6	0
Which provides better charcoal?	3	2	2	1	3	1
Which provides better fodder?	3	2	2	6	1	5
Which provides better manure?	2	3	1	7	1	5
Which provides better shade?	3	2	0	8	0	6
Which is more useful overall?	2	3	2	6	1	5
Which is planted more?	4	1	7	1	4	2

crops. Eight farmers reported that *G. robusta* had negative effects, although its effects were the least among the exotic species. Only one farmer reported that *C. africana* had greater negative effects on crops than *G. robusta*. *C. africana* was even found within crop fields, whereas *G. robusta* grew mostly along the farm boundaries.

Discussion

Indigenous tree species, including *C. africana*, were reported to be used for multiple purposes, whereas exotic species were mainly used for wood resources including timber and firewood, thereby contributing less to farming and food supply (Table 2). The overall responses by farmers indicated that *C. africana* was more useful than *G. robusta* (Table 3). Although *G. robusta* is thought to have fewer negative effects on crops than other exotic species (Harwood and Booth 1992), farmers believed that *C. africana* had a much lower negative effect than *G. robusta*. Furthermore, *C. africana* was believed to have higher timber quality than *G. robusta.* In fact, *C. africana* was sold as timber at higher prices than *G. robusta* in Meru and neighboring areas (Wekesa et al. 2005).

Despite the usefulness of *C. africana*, farmers wanted to plant more *G. robusta* trees than *C. africana* (Table 3). *G. robusta* and other exotic species were found in all the villages, even though rainfall conditions differed (Table 1). It is necessary for farmers to earn cash quickly by selling timber because they need cash to pay for school and other fees. Many exotic species have a higher growth performance than indigenous species, and *G. robusta* is one of the fastest growing trees (Jama et al. 1989; Okorio et al. 1994). Thus, *G. robusta*, which grows straight, can be a rapid source of high-quality timber. In addition, *G. robusta* may provide more of a daily contribution to farmers' livelihoods than *C. africana* by providing quick-drying firewood (Table 3). Thus, easily established, fast growing trees like *G. robusta* are better for farmers in terms of their short-term contribution to the household economy.

Aside from the short-term contributions, the advantages of *C. africana* and other indigenous species should be rediscovered, especially with regard to their long-term contributions as on-farm trees. The original significance of on-farm trees was in their contributions to farming before farmers began to recognize trees as commercial timber. Indigenous species are superior to exotic species as a form of support to farming (Table 2). In addition, the commercial value of *C. africana* as timber is not necessarily lower than that of *G. robusta*. The lower growth performance and relative difficulty of establishment of *C. africana*, as compared to *G. robusta*, can be compensated for by its higher timber quality and greater ability to produce stump sprouts. In fact, the long-term growth performance of *C. africana* is not necessarily inferior to that of *G. robusta* even though farmers believe that *G. robusta* grows faster (Takaoka 2008). Further studies are needed to obtain a comprehensive understanding of the long-term contributions of indigenous species to farmers.

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